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Full Length Research Paper

Credit risk management of commercial banks in Iran; Using logistic model

Hamid Sepehrdoust* and Adel Berjisian

Department of Economics, Bu-Ali-Sina University, Hamedan, Hamedan Province, Iran.

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The observed crisis and profitability decreases in banking system are mainly because of the inefficiency in credit risk control and that's why, utilization of customers' ranking system is the most important tool that is required for managing and controlling the risk. The goal of the study was to present an applied model for credit scoring of real entity customers of banks with reliance on statistical information of credit customers of Parsian Bank in Iran. For this purpose the logistic regression model is used to analyze credit ranking and financial scoring of bank's customers based on their previous and current data record like; job stability, collaterals, income and some other main indicators for estimating non-default probability of facilities offered to each customer. The results of the model estimation showed that non-default probability of facilities have positive relation with variables amount of collaterals received from customer, monthly income amount of the customer, the status of applicant for taking facilities such as place of residence (be owner or tenant of the applicant), the age of applicant for taking facilities, occupational status of the applicant as stability and educational level of the applicant for taking facilities and have negative relation with amount of paid facilities to the customer and payback duration of granted facilities to the applicant.

Key words: Risk management, credit risk, commercial bank, logistic regression.

INTRODUCTION

Financial sector is the backbone of economy of a country. It works as a facilitator for achieving sustained economic growth through providing efficient monetary intermediation. A strong financial system promotes investment by financing productive business opportunities, mobilizing savings, efficiently allocating resources and makes easy the trade of goods and services (Jah and Xiaofeng, 2012). Banks as institutions that are looking for maximum profitability have responsibility for increasing the value of shareholders' equities on one side and attracting the customer satisfaction in the other side. The role of the banking industry is crucial in the pattern and pace of economic growth and development (Mogboyin et al., 2012). As it is well articulated and established in the literature (Demirguc-Kunt and Huizinga, 1997), banks occupy a position in the financial system that supplies the credits need of the economy. Both theoretical and empirical evidence suggests a positive correlation between real economic growth and banks assets-especially credits (Alashi, 1991). On the other hand since a considerable part of banks' income are resulted from absorbing resources of investors and granting facilities from the credits, therefore, they are always encountering with an important and challengeable issue of credit risk at the time of granting facilities. Many studies show that, evaluation of banking system customers risk in Iranian banks relies on expert's judgment and fingertip rule. This type of evaluation resulted in high rate of postponed claims (Salehi and Mansoury, 2011).

Risk is a concept that denotes a potential negative impact to some characteristic of value that may arise from a future event (Mojtahedi et al., 2009), or one can say that exposure to the consequences of uncertainty constitutes a risk. In everyday usage, risk is often used synonymously with the probability of a known loss. Risk communication and risk perception are essential factors

*Corresponding author. E-mail: hamidbasu1340@gmail.com.

foe all human decision making (Cooper et al., 2005). The meaning of credit risk is non-receiving cash flows of granting facilities by banks that exact timely evaluation and examination thereof, especially for average and small facilities and this requires a systematic method. Credit risk management from the primary stages of granting facilities up to the examination time of application for receiving facilities are performed by credit experts and also supervision process over granting credit. In contemporary organizations, risk management has become established as a particular method and practice of viewing and attending to such risks. As a social and cultural phenomenon, in itself, it assumes and prescribes particular views of the nature, forms, degrees and methods of dealing with risky businesses (Giddens, 1999; Power, 2008). In fact, it is required that banks examine the applicant's ability in payback of obligations and estimating the probability amount of non-fulfillment of obligations in future (non-default of facilities paid) before any payments to them through credit risk management, customers' ranking and scoring instruments toward decreasing credit facilities risk. According to Basel committee, credit risk is most simply defined as the potential that causes a borrower or counter party not to meet its obligations in accordance with the agreed terms (Gumparthi et al., 2011). The reason behind it is that when the facilities are not recovered, the loss resulted from non-default created and therefore, bank must consider the proper coverage due to loss existence probability.

Credit scoring is an instrument used to manage the risk that takes action toward ranking of customers by using quantitative statistics and information of facilities applicants and also statistical techniques (Mester, 1997). With the right credit scoring model, the bank can evaluate any new or existing profiles of customers accurately, enabling them to minimize potential risks that might be looming. Credit rating systems is used to categorize the risk's worthiness of a person as high, medium or low. This allows for decision support by accepting, extending or rejecting any credit request (Sheng and Ying, 2011).

Credit scoring models divides the credit applicants into two: good and bad credit groups. Good credit group is a group that payback their dues timely and bad credit group is a group that will probably not pay their dues (Lee et al., 2002). The Basel committee has defined credit rating as a 'summary indicator' of the risk inherent in individual credit, embodying an assessment of the risk of loss due to the default of a counter party by considering relevant quantitative and qualitative information. Credit rating, through the use of symbols, can be defined as an expression of the opinion about credit quality of the issuer of securities with reference to a particular instrument. Rating is a measure of credit risk and is only one element in investment decision making (Gumparthi et al., 2011).

Some of the benefits of credit scoring system are shortening the granting facilities process, more quick performance and reduction of credit risk toward responding increase in demand for credit products of bank. Credit scoring has obvious benefits in relation to decreasing the required time for approving facilities that causes increase in its usage in evaluating facilities. This method decreases the required time in facilities approving process. Commercial banking union found that traditional process on facilities approving on the average is 12.5 h for each small commercial facility (Allen, 1995), while in past the facility takers spend more than two weeks in this regard. Credit scoring can decrease this time to less than one hour. Therefore, Barnet Bank in its annual report confessed that the time spending on approving facilities for real entity customers or small commercial firms that was three or four weeks in the past, could be decreased to less than three hours by using the above-mentioned system (Lawson, 1995). Leonard (1995) in his study on a Canadian Bank found that after using this system for 18 months, facilities approving time that was nine days before stating the use of credit scoring system decreases to three days. Of course, scoring is vastly using in mortgage issues since the Federal National Mortgage Company encourages mortgage facilities grantors to use credit scoring system (Dezube, 1996). The goal of this study is presenting an applied model for credit scoring of real entity customers of banks with reliance on statistical information of credit customers of Parsian Bank.

LITERATURE REVIEW

The economic literature of 1950s, defines the word risk and non-assurance as knowledge related to occurrence and/or non-occurrence of event. From years relevant to 1980s henceforth, risk and non-assurance get separated and risk is applied to the condition that there was more than one event for each decision making and the occurrence probability for each event not to be distinct and definite (Greuning and Brajovice, 2003). Risk in banking defines as fluctuation or standard deviation of cash flows of a bank and its goal is augmenting shareholders' equities through acquiring ability toward achieving commercial and financial goals and maximizing the output after considering the risk. A systematic process of risk management is divided into risk identification, risk analysis and risk response (Li and Liao, 2007; Duijne et al., 2008). Risk identification requires recognizing and documenting the associated risk. Risk analysis examines each identified risk issue, refines the description of the risk and assesses the associated impact. Finally, risk response identifies, evaluates, selects and implements strategies in order to reduce the likelihood of occurrence or impact of risk events (Mojtahedi et al., 2009). In banking industry, risk is classified into four main groups including operational risk, commercial risk, event risk and financial risk. Financial risks are divided into two different risk groups: first group includes risks relevant to fluctuation in interest rate, currency and market rate, and second group includes pure risks as liquidity risk and credit risk and in the case of mismanagement, these two groups directly causes bank's loss (Joel, 2009).

Credit risk means a risk resulted from inability of facility receiver in payment of the obligations to bank and/or risk of non-returning of original and profit amount of investment which caused decrease in current value of bank’s assets (Altman, 1998). Basel Committee working under the supervision of international settlement bank of Swiss for assimilating banking rules, defines credit risk as potential probability in which facility receiver get incapable toward fulfillment of its obligations against bank within certain duration (BCBS, 2000).The origin of creation the credit risk may be observed in compilation of three risks that are respectively include: default risk, recover risk and exposure risk (Joel, 2009). Default risk or non-default probability of debts by the loaner is a loss if occurred, threatens the bank. Therefore, credit risk rooted in probability in default or non-default of facilities by facility receiver and its occurrence probability fluctuate in the range of zero and one. Payment default informed by a bank institution when scheduled installments not to be paid within a certain duration after due date. Default may be economic and occurred when economic value of assets or the current value of expected future cash flows become less than the value of non-deposited debts. Loss resulted from default is pending on default definition and default definition is pending on estimating default probability (resulted from past data). Ranking agencies consider the default event after passing three months from due date of a scheduled payment and no payment performs during this period, therefore, theoretical models of credit risk which propounded after Merton model (Merton, 1974), apply economic default definition for measuring of losses amount. It is noteworthy that, different default events necessarily not to create immediate loss but increase the probability of permanent default or bankruptcy. Default risk measures through the probability of occurring default within certain duration. Of course, default probability may not be measured directly, but must be used from statistics collected from default in the past that credited from system interior.

Usually, previous statistics of default and ranking of agencies are proper and accepted standards of default which uses as a symbol of default risk. In the case of non-accessing of agencies’ ranking, we can use estimation about default probability based on specifications of some applicants (real or legal). Followed by John Murray in 1909 and ranking of credit risk on bonds, some researchers realized approximation between bonds and paid facilities and examined the measurement of non-default risk of original and interest of facilities (Kiss, 2003). In this regard one may point out to the Fisher’s study (Fisher, 1936) focused on the fundamentals of credit scoring method as the first evaluation system of credit demand. Dunham (1938) engaged in his studies for designing a credit risk system, used five important standards including existing condition, revenue conditions, financial conditions, guarantors or Collaterals and facilities payback information of other banks. Considering these factors, the objective of credit scoring models is to assign credit applicants to either a “good credit” group that is likely to repay financial obligation or a “bad credit” group with high possibility of defaulting. Therefore, credit scoring problems are basically a classification problem (Johnson and Wichern, 2002). Accurate credit quality estimation systems will substantially improve the profitability of the banking institutions (Thomas et al., 2002).

Many studies have been conducted in this regard as follows. Durand (1941) in his studies examined which variable has been important from facility providers’ point of view and which specifications are statistically considerable for credit risk management. The most important variables examined included: applicant’s job, job stability, residing years at the current place, bank accounts, saving and life insurance policies, sex and monthly installments amount that the applicant must be paid. Most experts know Durand as founder of current credit scoring system. Isaac – Fair Institute (1996) found the necessity for application and development of credit scoring systems of credit facilities’ customers that needs continuous collecting and updating of data. Bogess (1967) for the first time in an article suggested using computer for developing scoring models, evaluation of mass facilities products and increasing algorithm-writing skills which caused possibility for examination and studying a bog data collection from different point of views. He examined complicated tools of multiple criteria statistical methods which lead to creating much clearer models. Jah and Xiaofeng (2012), compared the financial performance of different ownership structured commercial banks in Nepal based on their financial characteristics and identify the determinants of performance exposed by the financial ratios for the period 2005 to 2010. The results show that public sector banks are significantly less efficient than their counterpart are; however domestic private banks are equally efficient to foreign-owned (joint venture) banks. Owojori et al. (2011), managed to provide an overview of risk management practices in insured banks in Nigeria. The employed trend analysis of variables to derive its results and concluded by pointing to some steps that would help to preserve the banking system and sustain its impact on our fragile economy. Sheng and Ying (2011) studied the use of batch and incremental classifiers such as logistic regression, neural networks and C5 to obtain the best classifier to be used for improving the predictive accuracy of consumer's credit card risk of a bank in Malaysia.

Results showed that C5 emerged consistently as the technique that have generated the best models with an average predictive accuracy as high as 94.68%. Huang and Wu (2011), studied the customer credit quality assessment for banking industries, by using boosting and genetic algorithms (GA). The empirical results indicated that GA substantially improves the performance of underlying classifiers. Considering robustness and reliability, combining GA with ensemble classifiers is better than traditional models. Zribi and Boujelbene (2011), aimed to examine the determinants of bank credit risk in ten commercial banks, taking into account both macroeconomic factors and microeconomic variables that are likely to influence credit risk. Overall, the results show that the main determinants of bank credit risk in Tunisia is: ownership structure, prudential regulation of capital, profitability and macroeconomic indicators. The empirical results show that the public ownership increases the bank credit risk. Other authors that have written in the field of designing a risk measurement model include Beaver (1966), Altman (1968) and Morgan (1994).

The importance of increasing the degree of credit risk in Iran also has led to studies in this area. Zekavat (2003) in a research inspired by Altman model, examined credit risk models of customers of Tosea Saderat Bank. Mansouri (2003) in his study used regression and neural networks models for evaluating customer's credit risk of Mellat Bank. Arabmazar and Roueintan (2006), made an attempt to evaluate the credit risk of legal customers of Keshavarzi Bank Iran and examined qualitative and financial information of a 200-member random sample of companies which received credit facilities from Bank. Safari et al. (2010) took action toward presenting a model for credit ranking of legal customers of Tejarat Bank in Iran. Salehi and Mansoury (2011), have studied Iranian banking credit risk and formulated an intelligent model by neural network and logistic regression to evaluate individual customers' credit risk without prejudice and discrimination. The result revealed that neural network and logistic regression have the same ability in predicting customer credit risk. The main objective of the present study is to present a comprehensive model for credit scoring of real entity customers of banks with reliance on statistical information of credit customers of Parsian Bank in Iran.

MATERIALS AND METHODS

Data required for credit scoring of real customers have been collected from statistical information of Parsian Bank in Iran during the period of 2008 to 2010. Informative data are usually provided from data relevant to good pay and poor pay applicants. For example; in a similar study and through 5-year data of small commercial facilities less than 5 million dollar, a sample consist of data relevant to more than 5000 facility applicants related to 17 USA banks for creating a scoring model were examined (Asch, 1995) and variables used in this study are derived from five C (Character, Capacity, Capital, Collateral and Condition) model and based on five major standards for evaluating and granting regulated facilities. According to the five C model, facility providers for evaluating facility granting to its credit customers, for scoring and decision making makes use of a data bank of previous records of customer (Dunham, 1938). Type of used information in this model is pending on different conditions. This model used five major standards for evaluating facility granting to the customers. These include:

1- Character: is a standard for recognizing commitment rate of applicant for payback of credit facilities. Attended items include what was the credit background of customer and if he has ever been bankrupt? Whether previous creditors have been referred to the court?
2- Income capacity: is a standard for estimating income authority of the applicant. This standard evaluates financial authority of real or legal entity and answers to this important question that if the applicant has authority for payback of installments relevant to the applied facilities?
3- Capital: is a standard for analyzing capital and assets of the applicant which indicates customer's authority in payback of facilities.
4- Collateral: is a standard for recognizing type of free assets able to putting collateral including property and bank collaterals and any other collateral assure the creditor for compensating non-default loss.
5- Condition: is a standard for more recognizing of external environmental conditions which have effect on payback authority of credit commitments of creditors. Main axis of external environmental conditions is job security and/or job stability of the applicant.

Normally, the financial performance of commercial banks and other financial institutions has been measured using a combination of financial ratios analysis, benchmarking, measuring performance against budget or a mix of these methodologies (Avkiran, 1995). Depending on the commercial uses of credit scoring, the methodology to construct credit scoring models varies from bank to bank. It may involve firstly, a sample of historical records classified as "good" and "bad" depending on their repayment performance over a given period. Next, data could be obtained from internal or other external sources, namely, from credit bureau reports. Finally, statistical or other quantitative analysis is performed on the data to derive a credit scoring model (Koh et al., 2006). In this study the logistic regression model is used to estimate the model. Logistic regression is a type of regression analysis used for predicting the outcome of a categorical criterion variable based on one or more predictor variables. Referred to the target group, the criterion is coded as "0" to a "non-case" and "1" to a "case" in binary logistic regression as it leads to the most straightforward interpretation (Lemeshow and Hosmer, 2000). However, estimation of coefficients in this method is similar to ordinary regression model, but estimation method thereof is completely different. Because of nonlinear nature of logistic regression, coefficients of logistic model evaluate through general maximum likelihood (MLE) method. In logistic regression, dependent variables are a two-mode variable of (0 and 1) which allocated itself the amount of zero and one. If we suppose that Y is a random variable that can give up amounts of zero and one, therefore, probability of Y may be considered equations (2) and (3).

$$P(Y=1)=P=\frac{e^{\beta' X}}{1+e^{\beta' X}} \qquad (2)$$

$$P(Y=0)=(1-P)=\frac{1}{1-e^{\beta' X}} \qquad (3)$$

The symbol (β′) stands for vector of coefficients and the symbol(x) is column vector of independent variables. The above motioned equations may be considered equation (4).

$$\ln\left[\frac{P}{1-P}\right]=\beta' X \tag{4}$$

Equation (4) is an indicator of linear relation between independent variables and neoprene logarithm chance ratio. Whereas, chance ratio and logarithm thereof is not calculated directly, therefore, mentioned coefficient is estimated by maximum likelihood ratio. Considering each observation as a Bernoulli probability distribution, the equation (5) must be established for any observation.

$$P(Y=y_i)=Pi^{Y_i}(1-P_i)^{1-y_i}$$
$$(y_i=0,1) \tag{5}$$

The variable P_i is event probability in i^{th} observing and y_i is amount of random variable which can be zero and/or one (one for occurrence and zero for non-occurrence of event), while supposing that (n) is independent observation, therefore, likelihood equation will be according to equation (6) and with substituting Pi relevant to equation (2) in equation (6), we can reach equation (7).

$$L=\prod_{i=1}^{n}Pi^{y_i}(1-Pi)^{1-y_i} \tag{6}$$

$$L=\prod_{i=1}^{n}\left(\frac{e^{\beta' X}}{1+e^{\beta' X}}\right)^{y_i}\left(\frac{1}{1+e^{\beta' X}}\right)^{1-y_i} \tag{7}$$

By taking the natural logarithm of equation (7), we will have:

$$\ln L=l=\sum_{i=1}^{n}y_i\ln\left(\frac{e^{\beta' X}}{1+e^{\beta' X}}\right)+\sum_{i=1}^{n}(1-y_i)\ln\left(\frac{1}{1+e^{\beta' X}}\right) \tag{8}$$

Therefore, estimation of independent coefficients (β_i vector) is achieved through maximizing the above-mentioned equation which is calculated through derivation against each independent variable and when each of these derivatives is fixed, it is equal to zero. Of course, the above-mentioned equations have no analytical answer and solving the system of equations through Newton-Raphson method is possible (Ypma, 1995). Finally, on the basis of presented theoretical basics, research model is defined as description of equation (9).

$$Y=\beta_0+\beta_1 AM+\beta_2 CO+\beta_3 I+\beta_4 O+\beta_5 S+\beta_6 T+\beta_7 DE+\beta_8 AG \tag{9}$$

Where;

(Y): is a binary variable with the values of zero and one that indicate default and nonpayment of facilities.
(AM): is the approved amount of facilities requested by the customer and examination of customer's conditions from character, collateral, income capacity, capital and external conditions in facilities committee for payment to the customer.
(CO): is the amount of collateral which is given to the customer against granting the facilities such as title deed, cheque, draft, participation bonds and long-term deposit certificate. Toward quantifying the above-mentioned variable and using thereof in the model of collaterals respectively improved liquidity and being ensure by encoded and used as virtual variables. Participation bonds and long-term deposit certificate with code No. 2, title deed with code No. 1 and cheque and draft with code No. 0 were defined.
(I): indicates the monthly income of facility applicant that is entered directly into the model.
(O): indicates the ownership status of the customer regarding his /her residence place as owner or tenant. In order to quantify this variable, the code No. 0 is assigned to the applicant being a tenant and code No. 1 will be assigned to the applicant being an owner in the model.
(S): shows job stability of the applicant for facilities or duration that the customer employed at his/her current job, and in the case of employment at the current job for more than five years, his/her status from job point of view consider as stable. In this model, if the customer has stable status with code No. 1 and otherwise, with code No. 0 was identified.
(T): shows payback duration of facilities or duration within which the customer must pay back the facilities through predetermined installments. This model insert at the model monthly.
(AG): is the age of facility applicant, inserts directly in the model and
(DE): indicates the educational degree of the applicant which toward quantifying and using them as virtual, secondary school diploma and lower code: 0, associate's degree and bachelor's degree code: one and master's degree and higher code: two, were allocated.

A comprehensive model is constructed after attaching the weights. Each client will be rated on each of the parameters based on the scorecard provided. Each score of the client will be multiplied by the corresponding weights and a weighted score will be calculated for each parameter. The weighted scores of all the parameters will be summed to arrive at the final score of each client. Based on the final score, the client is given a rating by referring to the rating scale of the model. This final score decides the risk involved in operating with each client (Gumparthi et al., 2011).
In logistic regression estimation model, independent variable have binary status, it is required to use from minimum sample of 1000-observation (Whitehead, 2004). Therefore, for estimating suggested model of credit scoring, 1500 selected files of real entity customers of Parsian Bank which received credit facilities from bank were used. Parsian Bank is the biggest private bank of Iran with more than 4000000 customers and more than 10 years record has the most granted resources and facilities among private banks. It is noteworthy that, in the examined level and performing of this research, Parsian Bank has 279 branches. Due to the fact that default files need to be recognized after the period (date) of granting of facilities, and with reference to 150 older branches of Parsian Bank in Tehran which have more considerable credit files and based on cluster sampling, ten files from each branch including five files relevant to good pay customers and five file relevant to poor pay customers, whose facilities have been defaulted, were selected randomly.

RESULTS

In this study, in order to assess the designed optimum model, at the first, the relevant data of the above-mentioned variables for 1500 real entity customers of Parsian Bank were interred into the model through trial and error method by Eviews7 software. Then, in the

Table 1. Goodness of fit criterions.

McFadden R-squared	0.447687	Mean dependent var	0.500000
S.D. dependent var.	0.500167	S.E. of regression	0.346677
Akaike info criterion	0.777668	Sum squared resid.	179.1957
Schwarz criterion	0.809548	Log likelihood	-574.2513
Hannan-Quinn criter.	0.789545	Restr. log likelihood	-1039.721
LR statistic	930.9389	Avg. log likelihood	-0.382834
Prob (LR statistic)	0.000000		
* Obs. with Dep.=0	750	Total observations	1500
** Obs. with Dep.=1	750		

*Observations with zero value of dependant variable **Observations with unit value of dependant variable.

Table 2. Estimation results of logistic regression model.

Parameter	Estimated value	P-value
C	-4/182198	0/0000
AM	-0/001231*	0/0000
CO	3/803806	0/0000
I	0/011367	0/0000
O	0/698442	0/0032
S	0/307626	0/0479
T	0	0/0000
DE	0/731247	0/0000
AG	0/021451	0/0010

*Negative sign with the values indicates an indirect relation between the relevant variables.

estimated model, meaningfulness of coefficients through Wald statistics, meaningfulness of whole regression through LR statistics in confidence level of 95% and nonexistence of co-linearity between the variables and nonexistence of specified errors in the model were examined and result thereof are inserted in Table 1.

The test of LR statistics is similar to F statistics in linear regression model having chi-square distribution with k=8 degree of freedom (k is the number of independent variables of model) and is calculated by using formula $\left[-2(\bar{l}-l)\right]$ and achieved in 930.99389 as indicated in Table 1. The probability of LR statistics that is valued less than 0.05 and near zero indicates that within the confidence level of 0.95, the null hypothesis (Ho) is rejected, that is the regression result is meaningful. Mc. Fadden R-square statistics that is similar to R^2 statistics in linear regression derived equal to 0.447687 as shown in Table 1, which is acceptable considering similar studies for logistic model. Wald statistics is used for evaluating the meaningfulness of logistic regression variables coefficients. As considered in third column of Table 2, meaningfulness level of Wald statistics for all achieved coefficients is less than 0.05 which means that considering zero for all above-mentioned coefficients were rejected. Therefore, the above-mentioned co-efficients are meaningful.

In addition, Lemeshow-Hosmer test is used to examine the best fit of the model (Whitehead, 2004). Statistics of this test examines fit goodness of the model through grouping. In this examination, all observations of the sample were divided into 15 equal groups (100 observations each group). Statistics value of this test has chi-square distribution with k=8 degree of freedom and achieved in 19.9019 and its probability is 0.0977. Therefore, the null hypothesis based on equation (10) was approved and concluded that examined variables have much good proponent authority.

$$(H_0 : E[y] = \frac{e^{X'\beta}}{1+e^{X'\beta}}) \tag{10}$$

Therefore and finally the general figure of logistic equation is estimated as equation (11).

$$Y = \ln\left(\frac{p}{1-p}\right) = -4/182198 - 0/001231AM + 3/803806CO + 0/011367I$$
$$+ 0/698442O + 0/307626S - 0/012471T + 0/731247DE + 0/021451AG \tag{11}$$

In this study, Logistic model has been proposed for credit scoring of Bank's individual customers in order to approve or reject their requests for credit facilities. Considering the achieved coefficients from applying logistic regression model and estimating the equation as general form (11), that is required to obtain $\hat{Y}_i$ amount while putting relevant data of each facility applicants inside the introduced model and then put this obtained quantity in equation (12) in order to calculate value indicators of $\hat{P}_i$ for the mentioned customer.

$$\hat{Y}_i = \ln\left(\frac{\hat{p}_i}{1-\hat{p}_i}\right) \tag{12}$$

Indicators amount of $\hat{P}_i$ with a range of values from zero to one (0 - 1) for each facility applicants will be demon-strative of non-default probability of facilities by the

Table 3. Ranking sample of customers using Credit scoring model.

Rank	Customer code	Non-default probability	Rank	Customer code	Non-default probability
1	700	0.999999994	1491	518	0.0000001122
2	297	0.999999990	1492	176	0.0000001028
3	1167	0.999999970	1493	24	0.0000000849
4	1165	0.999999960	1494	726	0.0000000657
5	70	0.999999900	1495	344	0.0000000567
6	389	0.999999850	1496	411	0.0000000194
7	293	0.999999800	1497	406	0.0000000048
8	1164	0.999999690	1498	408	0.0000000035
9	1038	0.999999680	1499	1476	0.0000000028
10	783	0.999999620	1500	407	0.0000000010

customer. Evidently, through determining threshold limitations, if achieved probability is being more than the above determined limit, the possibility of bank facilities non-default is considered positive, otherwise, default of customer's facility is recognized to be possible. Of course, such probabilities achieved by the model can be classified into two types of classification expenses. First type error: when a bad customer is placed wrongly at good customer's group and the second type error: when a good customer is placed wrongly at bad customer's group.

As a result of the study, 1500-member of real entity sample customers of Parsian bank for facility granting, were ranked as shown in Table 3, using $\hat{P}_i$ indicator. For example; in Table 3, ten superior customers with highest non-default probability and last 10 customers with highest default probability were indexed. After calculating the non-default probability of customer's facilities and finally ranking them, it was observed that 700^{th} customer while obtaining non-default probability in 0.999999994 has higher priority against other applicants of the facility. In addition, non-default probability of 407^{th} customer achieved equal to 0.0000000010 and has lowest rank among applicants for facilities.

Conclusions

The results of the study indicate that for a sustainable growth in Iran, the banking sector of the country has to be effective and efficient to respond favorably to the needs of the productive sectors of the economy. Commercial banks as institutions aiming at maximum profitability are required to examine credit status of customers before any payment to the applicants for the purpose of control, decrease of credit risk and increase in efficiency level of facility granting process. On the other hand, risks are events or conditions that may occur and has a harmful effect, which requires to be effectively adopted for minimizing its undesirable results.

On the basis of discussions made, it has become clear that, credit risk management in banks and financial institutions propound in two levels of dealing with individual customers and also portfolio level in which credit scoring system is a plan to measure and control the risk, while dealing at customer's level. Performing this examination and results thereof has importance for a bank from different aspects such as shortening facility granting process, more quick performance, and decrease default risk of facilities and most important is acquiring indicators for credit risk measurement even individually or portfolio.

Nowadays, commercial banks in Iran are interested in execution of credit scoring system due to confronting more applicants of facilities and time-consuming of exact evaluation of applicant's status and preserving customers' satisfaction. On the basis of model estimation and acquired meaningful coefficients, the study comes to the conclusion that, safer received collateral, higher monthly income, more stable ownership and occupational status, higher educational degree and older age of the client on one hand and lower credit payback duration and amount of the value of the facilities on the other hand would eventually lead to increase in the non-default probability of credit facilities. That means, non-default probability of facilities have positive relation with variables amount of collaterals received from customer, monthly income amount of the customer, the status of applicant for taking facilities such as place of residence (be owner or tenant of the applicant), the age of applicant for taking facilities, occupational status of the applicant as stability and educational level of the applicant for taking facilities and have negative relation with amount of paid facilities to the customer and payback duration of granted facilities to the applicant.

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